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The Characteristics of Tortrix Moths' (*Tortricidae*) Occurrence in Apple Orchards

Charakterystyka występowania zwójkówek w sadach jabłoniowych

Sinopsis. The experiment was carried out in 1999–2002 on apple trees cv Cartland in three orchards in the Lublin region. The objective of the studies was to determine the conditions affecting the location of egg laying and the way of larvae feeding of the most important species of tortricids. The analysis of the results shows that the intensity of damaging fruit is different in various years and depends of the atmospheric conditions at egg laying. Cool and humid weather at the initial period of the vegetation of plants favours rich growth of shoots, thus ensuring the existence of only slightly lignified shoots for a relatively long period of time. In such conditions, butterflies find the most favourable microenvironment to lay eggs in the top parts of tree crowns while larvae have adequate conditions for their development and the source of easily assimilated food. However, dry and hot weather at plant vegetation is the factor which impedes the process of lignification of the tissues of young growth, which together with the decrease in humidity, provides much worse conditions for the larvae to feed on the top parts of the shoots. In this case, the number of tortricids larvae feeding on leaf rosettes and fruit increases significantly.

Key words: tortrix moths, apple orchards, occurrence, harmfulness

INTRODUCTION

Pests, both those of apple orchards and those of all the other orchard crops in different agricultural and climatic regions of Poland, are characterised by the diversity of population size of particular species and the extent of their harmfulness.

These changes are conditioned mainly by the changing microclimatic conditions, agrotechnological ones, cultivar diversity of planting structure and the development of commercial orcharding with the intensive use of chemicals. There has been obse-

rved a very harmful type of changes in orchards' biocenosis. In recent years, for instance, the tortrix caterpillars' significance as orchard pests has grown greatly. This has been confirmed in the articles by many authors, among others: Łęska (1972), Labanowski (1979), Pluciennik (1994), Pluciennik and others (1994).

MATERIAL AND METHODS

The tests were carried out in the years 1999–2002 in three apple orchards on apple trees cv Cortland within the lubelskie voivodship. The observations concerned determination of the number and intensity of feeding of the most important *Tortricidae* species in variable environmental conditions. The research was conducted using the methodology elaborated by the Institute of Plant Protection in Poznań (Kagan, 1976). For that purpose 15 apple trees in were minitored every apple orchard were chosen. On the chosen trees 5 branches were monitored every 6–7 days. The number of feeding tortrix caterpillars' and damaged leaf rosettes were analysed. In the studies the following species of tortrix moths were observed: *Archips rosana* (L.), *Pandemis heparana* (Den. et Schiff.), *Spilonota ocellana* (Den. et Schiff.), *Adoxophyes reticulana* (Hbn.), *Hedya nubiferana* (Haw.), *Pandemis cerasana* (Hbn.), *Archips xylosteana* (L.), *Archips podana* (Scop.).

WEATHER CONDITIONS

In the year 1999 the winter was cold and the summer warm. The spring was relatively cold – several times there were drops of temperature below -5°C (19 IV, 7 V) – which caused delay of the vegetation season. July was the warmest month. Mean temperature of this month ($+20^{\circ}\text{C}$) approached mean temperature for July during the last 10 years. First drops of temperature below 0°C were observed in 3rd 10 days' period of October. Relative humidity in that year ranged from 73% (in May) to 93% (in February).

The vegetation season of 2000 was warm and dry. From February, during the whole spring mean monthly temperatures were higher from means of many years. August was the warmest month in that year with mean temperature $+18^{\circ}\text{C}$. Several times the temperature exceeded $+30^{\circ}\text{C}$ (21 and 23 VI; 31 VII; 19, 20 and 21 VIII). Autumn was also warm and long. Temperatures below 0°C occurred not before the end 2nd 10-days' period of December. June and July in that year was characterised by low mean sum of rainfalls. It was almost twice as low as mean of many years for this months. The lowest relative humidity was in May – 62% and the highest in November – 92%.

Spring in the year 2001 was relatively cool. Summer temperatures approached the means of many years but the sum of rainfalls and relative humidity in this year was considerably higher than standard. The highest mean sum of rainfalls (260.9 mm) was in July and it was tree times higher than the sum of rainfalls of many years. Heavy rainfalls were observed in June and July. Almost throughout the season relative humidity was high.

The vegetation season in the year 2002 was characterised by warm and dry weather. From February till the late autumn mean monthly temperatures exceeded mean temperatures of many years. Drought lasted from the second half of May till the end of September. Also, relative humidity in that period was much different than standard for the region where the tested apple orchards were. First meaningful rainfalls were not observed before the end of vegetation season.

RESULTS

The seasonal change of preying places of tortrix moths is caused by the necessity of pest movement influenced by changing microclimatic conditions and the quality of nutrient elements within a tree-crown. The reason why tortrix moths start feeding on fruit is the declining quality of leaves caused by their natural ageing process or damage by other organisms. The preying of tortrix moth caterpillars of overwintering generation on generative organs is also determined by a high number of the pest. In the years of rainy and cool weather during the periods of flight and egg-laying by the summer generation of female *Adoxophyes reticulana* Hbn. simultaneous preying of caterpillars both on the fruit and on shoot peaks was observed where the microclimatic conditions and the quality of feed were suitable for the pest (Tab. 1). The weather-climatic conditions shows that the mean daily temperature of the air in June in the years 2000 and 2002 during a mass flight of *Adoxophyes reticulana* Hbn. equalled or was higher than the long-term average in this season. The relative humidity of the air was lower by 5–6% and insulation period was longer compared to the years 1999 and 2001. These conditions considerably influenced the microclimatic changes inside apple tree-crowns. The reaction of tortrix moth to the described microclimatic conditions (high temperature and low relative humidity of the air) was laying eggs in pupation sites of tortrix moth caterpillars of overwintering generation where the microclimatic conditions were more suitable for them. That is why in the leaves rolled by this generation of tortrix moth there were from 90 to 96% of summer generation caterpillars. For example, in the year 2000 strong determination of caterpillars of summer generation is evident for the occupation of previous generation's microhabitat, caused by drought and high air temperature. The dynamics of the occurrence of summer generation caterpillars on the leaves damaged by the winter generations of tortrix moths is shown in Tab. 2. In the years of low temperature and higher air humidity tortrix moths lay most of their eggs on the tops on young shoots. In the year 1999 – the daily average air temperature in June was considerably lower, and relative humidity of air was 7–8% higher than the long-term average. The intensity of insulation was also considerably lower. In these conditions the majority of summer populations of tortrix moth occurred on the better lit and heated top parts of tree-crowns.

In connection with the observed specific expansion of egg-deposits of *Adoxophyes reticulana* Hbn. in apple tree-crowns, dependen on weather conditions in the period of mass egg-laying, considerable differences were found in the degree of fruit damage by this pest. This fact is accounted for not only by colder weather in the second case but also by the plenitude of accessible food for hatched caterpillars. Thus, there is no need to look for other food. A big part

Tab. 1. The location of caterpillars of summer generation *Adoxophyes reticulana* Hbn. in apple tree-crowns

Microhabitat	The number of caterpillars on the 100 observed units			
	1999	2000	2001	2002
Fruit and adjoining leaves	2.2	8.4	3.2	4.5
Shoot peaks	25.6	0.0	16.1	0.0
Leaves rolled by previous generation	0.0	73.1	0.0	31.9

Tab. 2. Number of the summer generation caterpillars *Adoxophyes reticulana* Hbn. in rolled leaves by the previous generation

Variant of orchard	Caterpillars observed at 100 rolled leaves			
	III 10 days' period of June	I 10 days' period of July	II 10 days' period of July	III 10 days' period of July
1	38.0	27.2	35.1	13.2
2	54.1	45.1	44.2	39.9
3	43.3	44.5	36.5	38.1
4	36.4	46.0	32.4	29.8
5	57.2	51.1	48.0	48.1
Total	229.0	213.9	196.2	169.1

Tab. 3. The characteristics of *Archips rosana* L. egg-deposits expansion in apple tree-crowns

Years	Total number of deposits in the test	Expansion in tree-crowns (%)		
		On branches	On the main shoots and central lead	In the regrowth shoots
1999	538	23.3	58.9	17.8
2000	285	13.8	76.2	10.0
2001	617	21.7	63.7	14.6
2002	493	21.1	65.2	13.7

of the population of tortrix moth stops preying on fruit at that time, which significantly lowers their economic importance. However, in the case of strong damage of regrowed leaves by *Venturia inaequalis* (Cooke) Aderh. or *Podosphaera leucotricha* Salm. caterpillars, caused by worse food quality, they have to migrate to fruit. The above analysis shows that there is a straight inter-

dependence between the quality of leaves and harmfulness of tortrix moths. The same interdependence was observed in the expansion of egg-deposits in apple tree-crowns also in the case *Archips rosana* L. (Tab. 3).

DISCUSSION

The conducted studies revealed significant differentiation, both in the intensification of the occurrence and the way in which apple orchards are inhabited by tortricids, depending on the climatic conditions of an individual season.

Hitherto existing studies fairly specifically characterise the dependence of the dynamics of the appearance of individual species on meteorological factors (Koślińska and Golikowa, 1978; Labanowski, 1979; Pluciennik et al., 1998). However, the changeability of the location of the tortricids population in the course of their development has not been clearly determined. This problem appeared to be one of the most significant factors determining the range of perniciousness of these butterflies in a particular vegetation season.

It should be stressed that the significance of tortricids as pests is affected not only by the numbers in of their population, but especially the duration and way of their feeding. Therefore, the results discussed in this study prove that the damage to the fruit was in the greatest extent caused by tortricids in the conditions of warm and dry weather at laying eggs by the females of the summer generation. Such conditions forced the butterflies to seek sheltered places to lay eggs like, for example leaves folded by the larvae of the wintering generation and the leaves adhering the fruit. Thus, a significant number of larvae growing in a direct neighbourhood of fruit ovaries, constituting in such climatic conditions more adequate (than the tops of shoots) site for feeding, was observed.

However, in the vegetative seasons characterised by low temperature and high relative humidity the top parts of the shoots were more beneficial places for the development of larvae. The choice of this type of microbiotope results from slower, than in the case of dry weather, process of lignification of young shoots and easier access of sunshine, ensuring the existence of adequate thermal and humidity conditions and advantageous quality of food in the place of caterpillars' growth. On the basis of the observations it was found that there is a direct relationship between the extent of damage by disease or leaves' ageing and the rise in intensity of tortrix caterpillars' preying on fruit.

CONCLUSIONS

1. The choice of preying places by tortrix moths is conditioned by changing microclimatic conditions in the tree-crown.

2. Preying of caterpillars on leaves is caused mainly by the process of leaves' ageing and by the growth of the pest population.

3. In the seasons with high air temperature and low relative air humidity most caterpillars of summer generation developed in the leaves rolled by the winter generations.

4. In the years with low air temperature and high relative air humidity most eggs laid by tortrix moths were situated on the tops of young shoots.

5. The extent of fruit damage caused by tortrix caterpillars is conditioned by weather conditions prevalent in the period of mass egg laying by moths.

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STRESZCZENIE

Doświadczenie wykonywano w latach 1999–2002 na jabłoniach odmiany 'Cortland' znajdujących się w trzech sadach na terenie województwa lubelskiego. Celem badań było określenie warunków determinujących miejsce składania jaj oraz sposób żerowania larw najważniejszych gatunków zwójków. Analiza uzyskanych wyników wskazuje, iż intensywność uszkodzania owoców w poszczególnych latach jest zróżnicowana i zależy od kształtowania się warunków atmosferycznych w czasie składania jaj przez motyle. Chłodna i wilgotna pogoda występująca w początkowym okresie wegetacji roślin, sprzyja bujnemu wzrostowi pędów, zapewniając tym samym utrzymywanie się przez stosunkowo długi czas słabo zdrewniałych tkanek. W tych warunkach motyle znajdują bardziej korzystne mikrosiedlisko do składania jaj w wierzchołkowych częściach koron drzew. Larwy zaś, posiadają tam dogodne warunki dla swojego rozwoju oraz źródło łatwo przyswajalnego pokarmu. Natomiast sucha i upalna pogoda występująca podczas wegetacji roślin jest czynnikiem przyspieszającym proces drewnienia tkanek młodych przyrostów, co wraz ze spadkiem wilgotności, stwarza znacznie gorsze warunki dla żerowania larw na wierzchołkowych częściach pędów. W tym przypadku zdecydowanie większa liczba larw zwójków rozwija się żerując na rozetkach liściowych oraz owocach.

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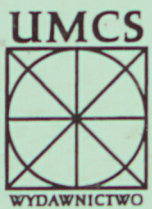
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